

EFFECTS OF PREDATOR PRESENCE ON THE NESTING DISTRIBUTION OF WHITE-CROWNED PIGEONS IN FLORIDA BAY

ALLAN M. STRONG,¹ RICHARD J. SAWICKI,¹ AND
G. THOMAS BANCROFT¹

ABSTRACT.—From 1987–1989, we conducted surveys throughout Florida Bay, Card and Barnes sounds, the southern portion of mainland Florida, and the mainline keys south to Long Key to determine the breeding distribution of White-crowned Pigeons (*Columba leucocephala*). We found pigeons nesting on 88 of 169 keys over a wide range in Florida Bay, Card and Barnes sounds, and in one location on the mainline Keys. Their nesting distribution appeared to be limited by the presence of raccoons (*Procyon lotor*). Of the 33 keys on which we found evidence of raccoons, only six had nesting White-crowned Pigeons. Other potential nest predators did not seem to influence nesting distribution. In Florida, White-crowned Pigeon breeding populations apparently are limited by the availability of nesting sites without raccoons. *Received 16 Nov. 1990, accepted 8 March 1991.*

The breeding distribution of the White-crowned Pigeon (*Columba leucocephala*) includes the Bahama Islands, the Greater Antilles, the Lesser Antilles south to Antigua, and the Florida Keys from the Marquesas Keys north to Elliott Key (Bent 1932, Goodwin 1967, AOU 1983). Additional breeding populations occur on offshore islands on the Caribbean coasts of Mexico (Quintana Roo), Belize, Honduras, Nicaragua, and possibly Panama (Bent 1932, Wetmore 1968, AOU 1983). The non-breeding range is slightly larger and includes peninsular Florida north to Fort Pierce, the Lesser Antilles south to St. Lucia and western Panama (AOU 1983). Habitat destruction, the taking of squabs, and over-harvesting of adults caused several authors to express concerns over decreasing population levels (Wetmore and Swales 1931, Owre 1978, Wiley 1979, Norton and Seaman 1985). Arendt et al. (1979) reviewed the status of the White-crowned Pigeon and listed populations as decreasing in the Bahama Islands, Cuba, Haiti, Dominican Republic, Puerto Rico, the U.S. and British Virgin Islands, Anguilla, St. Martin, and Nicaragua. Increasing or stable populations were cited in Florida, the Cayman Islands, Jamaica, Barbuda, Antigua, Mexico, Belize, Honduras, and Panama (Arendt et al. 1979).

The White-crowned Pigeon is listed as threatened in the state of Florida (Owre 1978). In 1976, the breeding population in south Florida was estimated to be 5000 pairs (Reeves 1977). However, the present population is mobile and widely dispersed even in the breeding season making

¹ Field Research Dept., National Audubon Society, 115 Indian Mound Trail, Tavernier, Florida 33070.

it difficult to obtain repeatable population estimates. Current protection has allowed the population to increase, but rapid clearing and development of tropical hardwood forests in south Florida is still a concern (Ogden 1973, Owre 1978).

White-crowned Pigeons are known to nest on offshore mangrove islands (Howell 1932), but little information is available on their nesting distribution. The objectives of the present study were to define the White-crowned Pigeon's breeding distribution in Florida Bay and investigate the factors limiting this distribution. Allen (1942) reported that raccoon (*Procyon lotor*) colonization of a mangrove island in Florida Bay supporting nesting Roseate Spoonbills (*Ajaia ajaja*) caused abandonment of the nesting site. We investigated the possibility that predators may have a similar influence on the nesting range of White-crowned Pigeons in Florida Bay.

METHODS

Study area.—We surveyed breeding White-crowned Pigeons on all mangrove keys throughout an area of approximately 1850 km² including Florida Bay, Barnes and Card sounds, the southern coast of the mainland, and the mainline Keys from Elliott Key south to Long Key (Fig. 1). An additional survey was conducted over a 63-km² portion of White-water Bay (Fig. 1) in mainland Everglades National Park. Most of the study area is within Everglades National Park, and the nesting islands are legally protected from human disturbance.

Florida Bay is a large, shallow estuary. The eastern bay is characterized by relatively deep (1–2 m) basins divided by narrow (often <200 m), shallow (<30 cm) banks (Schomer and Drew 1982, Powell 1987). Many of the keys within the eastern bay are situated along these banks (Fig. 1). Areas of higher elevations on the banks support red mangroves (*Rhizophora mangle*) which over time may develop into keys. In the western bay, the banks are larger, with maximum widths of more than 10 km. The keys in Florida Bay are typically fringed with dense stands of red and black (*Avicennia germinans*) mangroves. The outer edge is typically the highest part of the key and grades into a sparsely vegetated and shallowly flooded central lagoon. Some keys in the western portion of Florida Bay show the opposite configuration; a mangrove fringe grading into a higher elevation scrub forest.

The southern coast of the mainland and the mainline Keys are also bordered by red mangrove. Interior to the mangrove zone is a transitional zone of black mangrove, buttonwood (*Conocarpus erectus*) and salt-tolerant herbaceous plants. On the mainline Keys, the higher elevations support tropical hardwood forests. South of central Key Largo, much of this habitat has been cleared for development. On the mainland, the transitional zone grades to extensive mangrove forests interspersed with grass-dominated marshes, low elevation hardwood forests, and open water.

Surveys.—We conducted surveys for White-crowned Pigeons from early July through late August, typically the period of peak nesting activity (Bancroft and Bowman, unpubl. data). Most of the surveys were in 1987–1989; a few initial surveys were done in 1986. Surveys were conducted from sunrise to approximately 13:00 h. We followed the methods in Florida's Breeding Bird Atlas Handbook (Noss et al. 1985) to determine nesting status for each area searched. We walked through all suitable habitat when searching small keys; for larger keys, we set a pre-determined search time (generally 30–50 min) and covered as much of the key as possible during that period. For each area searched, we recorded the status and number

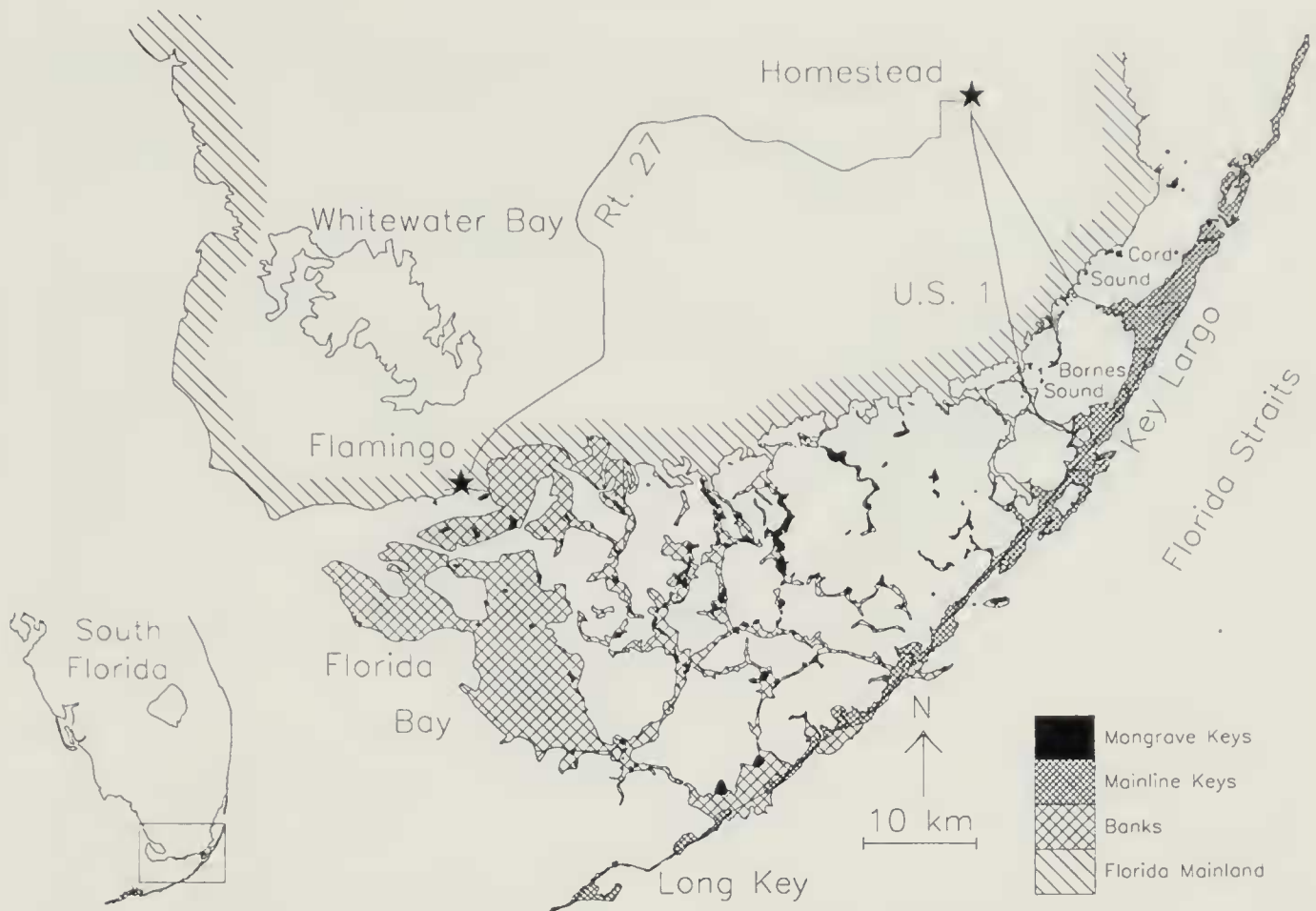


FIG. 1. Southern Florida study area and the arrangement of banks and mangrove keys within Florida Bay.

of active nests, number of old nests, and collective search time. In addition to recording White-crowned Pigeon nests, we noted the presence or sign of all potential nest predators. We determined nest detection rate by adding the number of old and new nests found in the area and dividing by the total time spent searching the area. A frequency distribution of nest detection rates revealed a natural break at 0.08 nests/min. We used this value to distinguish between areas of high (>0.08 nests/min) and low (≤ 0.08 nests/min) nest detection rates.

RESULTS

White-crowned Pigeon nesting distribution.—We searched 169 mangrove keys in Florida Bay, Card Sound, and Barnes Sound. A total of 384 nests were found in 204.1 h of surveys (number of nests found on individual keys, presence of predators, and survey times are available from the authors upon request). Number of nests found per key ranged from one on many keys to 22 on West Key. We found no nests on the mainland or in Whitewater Bay in 23.7 h of censuses. One nest was observed in 1990 in a development at the north end of Key Largo. No additional nests were found in 11.0 h of surveys on the mainline Keys from northern Key Largo north to Elliott Key. Development in this area is sparse and a substantial percentage of land is within Biscayne National Park, Crocodile Lake National Wildlife Refuge, or Key Largo Hammocks State

Botanical Site. National Audubon Society personnel have conducted extensive field work, including breeding bird surveys, in the tropical hardwood forests from north Key Largo to Long Key and have not detected any additional nesting activity. Therefore, we are confident that nesting on the mainline Keys is rare.

White-crowned Pigeon nests were found on 88 of the 169 mangrove keys surveyed (52%). Keys with nesting pigeons were widely distributed across Florida Bay (Fig. 2). Over an east–west gradient, White-crowned Pigeon nesting keys spanned the entire bay with the exception of two keys in the extreme western bay. Except for nesting in three disjunct areas, the main nesting distribution in the central bay was much farther from the mainland than in either the extreme eastern or western portions. In general, keys closest to the mainland did not support nesting pigeons, whereas keys closest to the mainline Keys often did.

Nest detection rates ranged from 0.01 to 0.71 nests/min. Because the keys vary substantially in size, similar nest detection rates do not allow direct comparisons of absolute population sizes. The area of highest nest detection rates was in the central portion of the bay, with the distribution constricted away from both the mainland and the mainline Keys (Fig. 2). Although several outlying keys did have high nest detection rates, detection rates in the extremities of the range usually were lower.

Two keys on the Florida Straits side of the mainline Keys had small numbers of nesting White-crowned Pigeons (Fig. 2). Also, two keys in Card Sound supported nesting White-crowned Pigeons (Fig. 3). The nesting location in Barnes Sound was the closest (0.3 km) to the mainland that we encountered. White-crowned Pigeons were nesting in isolated clumps of red mangroves on a spoil bank adjacent to Card Sound Road, separated from the mainland by a canal.

Distribution of nest predators. — Both avian and mammalian nest predators were recorded during our surveys. Potential avian nest predators were Red-winged Blackbirds (*Agelaius phoeniceus*), Laughing Gulls (*Larus atricilla*), and American Crows (*Corvus brachyrhynchos*). Red-winged Blackbirds were abundant throughout Florida Bay, where they occurred on 100 of 169 keys surveyed. Although Laughing Gulls were common and could be seen from the periphery of most keys, we found only three small nesting colonies during our surveys. We recorded American Crows on three keys in Florida Bay. They are common on the mainland, but are rarely observed on the mainline Keys.

We recorded the presence of four potential mammalian predators during the nesting surveys. Few were seen; most were identified by tracks or scat. The Virginia opossum (*Didelphis virginiana*) and bobcat (*Lynx rufus*) were found only on the mainland, the mainline Keys, and one key each

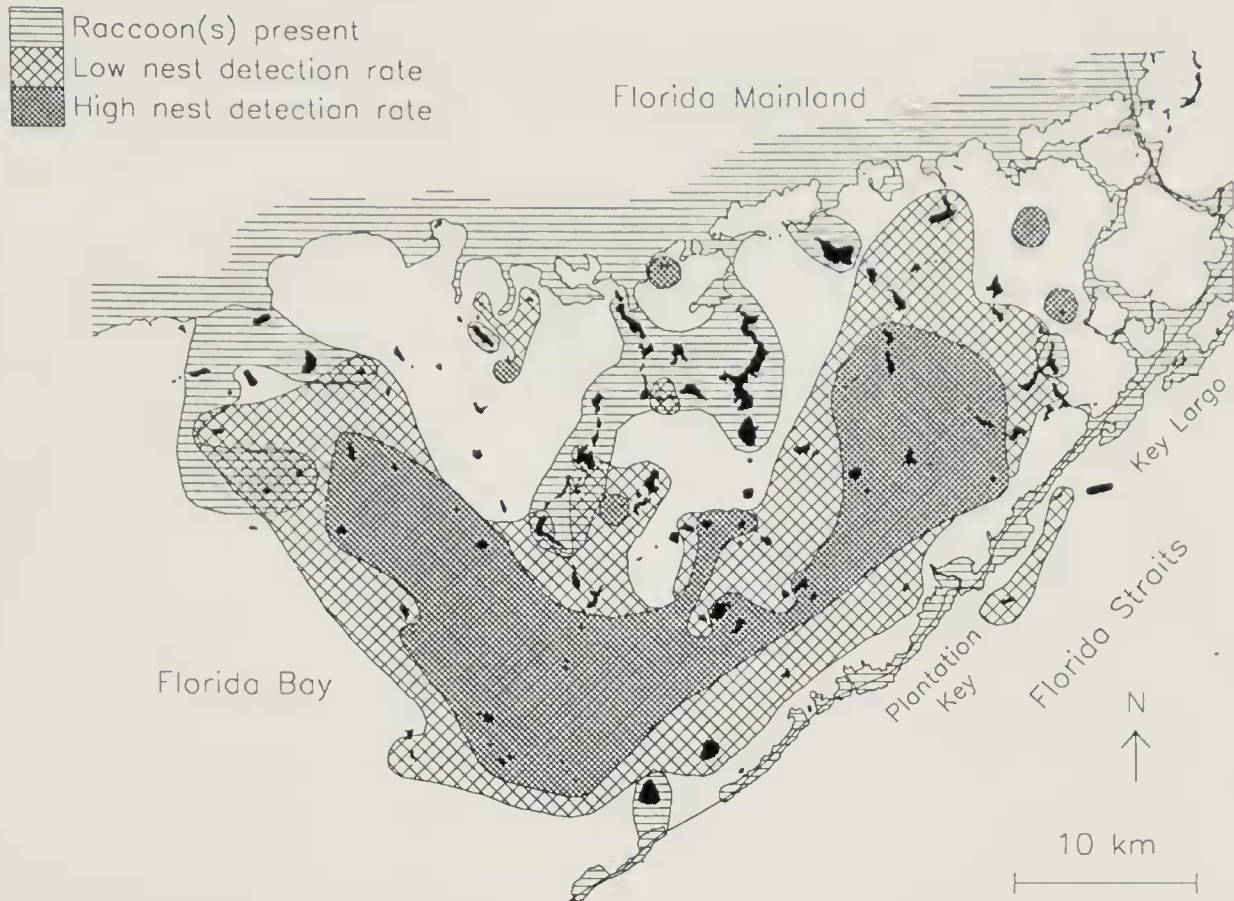


FIG. 2. Distribution of raccoons and areas of high and low nest detection rates of White-crowned Pigeons in Florida Bay, 1987–1989. Mangrove keys are shaded in black.

within Florida Bay. We recorded rats (*Rattus rattus* and *Rattus* sp.) on eight keys, widely dispersed throughout Florida Bay. Several keys harboring rats were not directly connected to the mainland or the mainline Keys by banks.

Raccoons were present and often common on the mainland and mainline Keys. In Florida Bay, and Card and Barnes sounds, we found evidence of raccoons on 33 keys (Figs. 2 and 3). The most widespread populations occurred in the north central and northwestern portions of the bay. In the northwestern bay, raccoons were found on seven keys. These keys, although widely separated, are connected by extensive banks (Fig. 1) that are exposed at low tides. In the north central bay, raccoons were located on 21 keys. All keys in this area are connected to each other and the mainland by banks (Fig. 1). In Figure 2, we depict the distribution as being continuous throughout this area. However, evidence of raccoon presence was found on only 21 of 32 (including the southernmost) keys within this chain. We feel raccoons must at least use the remaining keys in this range as travel lanes and are present on all of them for some portion of the year. Two keys adjacent to the mainline Keys had raccoon populations (Fig. 2).

Degree of overlap between potential nest predators and nesting locations. — Red-winged Blackbirds had the highest proportion of overlap with

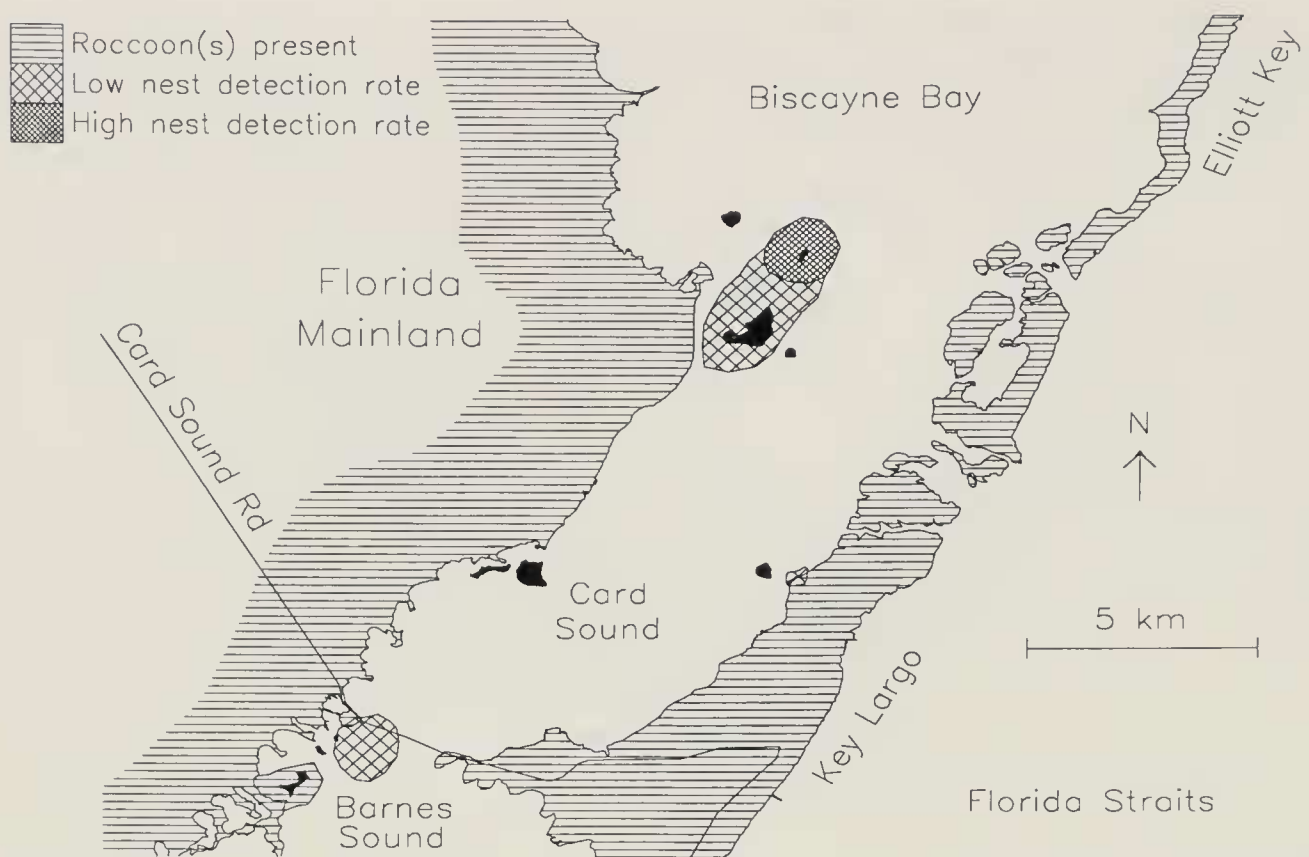


FIG. 3. Distribution of raccoons and areas of high and low nest detection rates of White-crowned Pigeons in Card and Barnes sounds, south Florida, 1987–1989. Mangrove keys are shaded in black.

nesting White-crowned Pigeons. They occurred on 59 of 88 (67%) keys with nesting pigeons. This occurrence rate was actually higher than we found on non-nesting keys ($G = 4.43$, $P < 0.05$).

The three keys on which we recorded nesting Laughing Gulls all had nesting White-crowned Pigeons. We were mobbed by Laughing Gulls on an additional seven keys, all of which supported nesting White-crowned Pigeons. Two of the three keys on which we recorded American Crows had nesting White-crowned Pigeons. All three of the keys with crows also had wading bird or Brown Pelican (*Pelecanus occidentalis*) and Double-crested Cormorant (*Phalacrocorax auritus*) colonies.

Of the eight keys that supported rats, five had nesting White-crowned Pigeons. Three of these keys had high pigeon nest detection rates. Neither of the keys on which opossums or bobcats occurred had nesting pigeons. Of the 33 keys that supported raccoons, only six (18%) had nesting White-crowned Pigeons. The proportion is similar (9 of 44 keys, 20%) if the entire chain of keys in the north central bay is considered to be occupied by raccoons. All of the keys that supported both raccoons and pigeons had low nest detection rates (range = 0.01 to 0.08 nests/min).

The proportion of nesting keys with raccoons is significantly different than the proportion of non-nesting keys with raccoons ($G = 19.97$, $P < 0.005$). The maximum number of nests found on keys containing raccoons

was seven. Three keys had four to seven nests; however, these were small keys and the total number of nests found probably represents most of the nesting population.

DISCUSSION

White-crowned Pigeon nests are relatively easy to locate. Adults remain on nests until an intruder approaches closely and then they flush with loud wing claps. Thus, we feel that we have described accurately the current nesting distribution of White-crowned Pigeons in Florida Bay and Card and Barnes sounds. White-crowned Pigeons also nest south of Long Key on offshore islands along the mainline Keys, but the current nesting distribution and population status in this area is unknown (T. Wilmers, pers. comm.).

Although Figures 2 and 3 represent the current breeding distribution of White-crowned Pigeons, temporal shifts in distribution may occur even in areas with high nest detection rates. West Butternut, a small key on which we monitored reproductive success, experienced a reduction in nesting pigeons from 1987–1989 (with 68 nests in 1987, 15 nests in 1988, and only one nest in 1989), whereas Middle Butternut, located 0.5 km away, supported more than 100 nests throughout this period (Bancroft and Bowman, unpubl. data). We have no explanation for this decrease.

In Florida Bay, pigeon nesting occurs in a broad, V-shaped band that diverges from the mainland in the central portion of the bay. Low nest detection rates or the absence of pigeons on keys with a high incidence of raccoons suggests that raccoons at least limit the distribution of high density nesting areas. The distribution of raccoons is nearly parapatric with that of pigeons. The only overlap occurred at the outer edges of the nesting range on six keys with low nest detection rates. Four of these keys had nest detection rates less than 0.04 nests/min, and two keys had only one old nest. We found no evidence of nesting by White-crowned Pigeons on the mainland or most of the mainline Keys. We feel that this is a response to high densities of mammalian predators. Wiley (1979), however, reported six nesting locations on Puerto Rico, suggesting that in other localities, mammalian predators may not exert such an influence.

The presence of sympatric raccoons and nesting pigeons may indicate recent raccoon colonization of a particular key. We have no indication of how effective raccoons are as predators on White-crowned Pigeon nests. They have been cited as nest predators on a variety of both ground- and tree-nesting species (Allen 1942, Lopinot 1951, Rearden 1951, Kilham 1986, Frederick and Collopy 1989, Post 1990). Wilcove (1985) felt that nest predation by mammals was less significant at nests greater than 1 m above ground level. Because White-crowned Pigeons frequently nest 1–2

m above ground, colonization of a nesting key by raccoons may not immediately eliminate the pigeon population. Raccoon scats found in Florida Bay contained primarily fish, crab, and shellfish fragments. Consequently, the two species may temporarily coexist on a key.

The current raccoon distribution reflects the unique arrangement of shallow mud banks in Florida Bay. Over the past 50 years, raccoons have been observed on additional keys within Florida Bay (Allen 1942; R. Paul, W. Robertson, pers. comm.), indicating that populations may be fairly mobile. Most raccoons probably reached mangrove keys from the mainland by following these banks and swimming across deeper channels. Raccoons on the keys in the southern and eastern portions of the bay most likely colonized from the mainline Keys. Although the intracoastal waterway separates the mainline Keys from keys within Florida Bay, mud banks still allow access to these keys with minimal swimming.

Allen (1942) felt raccoon distribution and abundance in Florida Bay was correlated with the occurrence of hurricanes. Moderate to large hurricanes occur in Florida Bay at approximately 20–25 year intervals (Gentry 1974). These events most certainly decimate the raccoon population on many keys in the bay and may periodically push the raccoon range back to the mainland, allowing the central bay to remain raccoon-free.

The influence of other potential predators seems to be minimal. Red-winged Blackbirds can be effective nest predators at unattended nests (Blankinship 1977, Sprunt 1977, Bancroft and Bowman, unpubl. data). In Florida Bay, the absence of human disturbance on nesting keys probably increases nest attentiveness and diminishes the effect of blackbird predation. However, blackbird predation may be a factor in areas where human disturbance is unregulated, such as keys in the Florida Straits and in Card and Barnes sounds. The high degree of overlap between Red-winged Blackbirds and pigeons suggests that blackbirds may also avoid keys with raccoons.

All 10 keys on which we recorded Laughing Gull nesting or mobbing activity supported nesting pigeons. Frohring and Kushlan (1986) listed Laughing Gull nesting colonies on 26 keys in Florida Bay. We found White-crowned Pigeons nesting on 24 of those keys and two additional keys that were not documented as nesting sites for gulls. Therefore, we do not suspect that gulls play a major role in limiting pigeon nesting distribution. Crows (*Corvus* spp.) have been cited as nest predators in a number of other studies (Burger and Hahn 1977, Verbeek 1982, Shields and Parnell 1986). However, in Florida Bay, crow distribution seems to coincide with wading bird, pelican, and cormorant colonies. White-crowned Pigeons did not nest on two keys with major wading bird colonies in

Florida Bay, but were found in high densities in a wading bird colony in the northeastern bay. Of the three keys on which we recorded crows, one had high pigeon nest detection rates, one had a single nest, and the other had no nesting. Therefore, the influence of crows is difficult to evaluate.

We found evidence of rats on eight keys, including keys with both high and low pigeon nest detection rates. Although rats have been cited in the reduction or elimination of several ground or burrow-nesting island birds (Austin 1948, Kepler 1967, Berger 1972:86, Cruz and Cruz 1987), their presence on keys does not seem to preclude nesting by White-crowned Pigeons. Wiley and Wiley (1979) reported *Rattus rattus* depredation on White-crowned Pigeon nests in Puerto Rico when lowered water levels permitted easier access to nest trees. Given the wide (but patchy) distribution of rats and their secretive and nocturnal behavior, they may be more common than we observed during the nesting surveys. As with raccoons, rat populations may be regulated by hurricanes.

The future breeding status of White-crowned Pigeons in the Florida Keys is threatened by two factors. First, expansion of raccoons to more keys in Florida Bay could make additional islands unsuitable for nesting. Human habitation, especially in the mainline Keys has caused localized increases in raccoon populations and thus increased the probability of raccoon dispersal into Florida Bay. Second, and possibly more important to the long-term survival of the White-crowned Pigeon in south Florida, is the clearing of tropical forests. White-crowned Pigeons feed exclusively on fruits of tropical hardwood trees found in these forests and current development presents a threat to their food base. Data from this study can be used to evaluate future changes in White-crowned Pigeon demographics and may be used as an indicator of changes in the food base or predation pressure in certain parts of their nesting range. The presence of Everglades National Park has probably ensured the survival of White-crowned Pigeons in south Florida by protecting both foraging and nesting habitats. However, conservation of the remaining tropical forests on the mainline Keys may be the overriding factor that determines the future success of White-crowned Pigeons in south Florida.

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